Original Research Article

IJCRR
Section: Healthcare Sci. Journal
Impact Factor 4.016
ICV: 71.54

Current concepts of SEAS (Scientific Exercise Approach to Scoliosis): Adolescent Idiopathic scoliosis (AIS)

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ABSTRACT

Adolescent Idiopathic scoliosis (AIS) is a habitual curvature of spine with unknown aetiology with an approximately of 5% of incidence rate. Prevalence ratio in females is well known. Literature reports have tried to explain the Prevalence in selected populations, possible ways of legacy, related to nutritional deficiency, environmental stress and over physical stress which may be a character for the evolution to the irregularity of the spine. SEAS "Scientific Exercise Approach to Scoliosis", is a potent modern neurophysiologic approach designed to stimulate the reflex and to improve the functioning of spinal musculature. It is employed in idiopathic scoliosis with low-medium degree curves below 200 during growth attempting to minimize the progression of Cobb angle. The mean of this paper is to review and update concepts of determined self-correction approach carried out without external aid in group settings with the assistance of trained family members and teachers.

Key Words: Scoliosis, Risk factors, Screening, SEAS

INTRODUCTION

Idiopathic scoliosis is a pathological entity of unknown aetiology. It was first described by Hippocrates, the term "idiopathic scoliosis" was probably presented in the mid of the nineteenth century by Bauer; the term was used by Nathan in 1909, Whitman defined it in 1922, Cobb put the term in his classification, and promoted by the Scoliosis Research Society[1]. Idiopathic scoliosis is classified into three types: infantile, juvenile and adolescent idiopathic scoliosis. The age at which the scoliosis manifest determines the variability between the three types. The infantile type occurs from birth till 3 years, the juvenile type from 4 to 9 years of age, and the adolescent type from 10 to 16 years of age.

The other types of scoliosis are composed of neuromuscular scoliosis and congenital scoliosis. Neuromuscular scoliosis which can occur with neuropathic or myopathic conditions, like cerebral palsy, poliomyelitis and Duchene Muscular disease. Congenital scoliosis on the hand develops due to the vertebral anomalies that occur during pregnancy.

Vertebrae usually have minimum of three growth zones[2]. The presence of neural stem is associated with the growth of posterior arch and is different than the growth of vertebral body which is similar to growth of long bones. Vertebral bodies start to ossify in the third month of intrauterine life. All vertebrae other than C1, C2 and sacrum ossify from three primary ossification centres. Ossification begins in the lower thoracic and upper lumbar spine and passes on to both the cranial and caudal direction[3] .Once the primary centres appear in the vertebral arches, the primary ossification centres of the vertebral bodies appear successively within the cervical spine. The ossification of vertebral body starts in the lower cervical spine (C6 and C7).

The human skeleton consists of two rapid growth periods, the first one ranging from birth to 5 years and the second one during the onset of puberty[2]. The standing height at birth is about 30% to that of final height of an individual. The spine makes up to 60% of the sitting height, whereas the head represents 20% and pelvis the remaining 20%. The average sitting height varies from 34cm at birth, 62cm at the age of 5 years, whereas the height reaches 88cm for women and 92

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Received: 18.01.2017 **Revised:** 28.01.2017 **Accepted:** 10.02.2017

cm for men at maturity[4]. The spine length triples from the time of birth until adulthood. The length of vertebral column (C1 to sacrum) is around 24 cm at birth. The length of average adult spine averages 70cm in men and 65cm in women at maturity. The vertebral column comprises of 12cm of cervical spine, 28cm of thoracic spine, 18cm of lumbar spine and 12cm of sacrum.

FORMATION OF SCOLIOSIS

Idiopathic scoliosis has been identified to be related with hypokyphosis; which is thought to be the result of a disproportional growth of anterior and posterior structures. This theory states that the growth of anterior structures overpower the growth of posterior structures, and as a result forward bending causes the bodies of vertebrae at the apex to have a tendency to move out of the way by turning to the side[5]

There was no considerable difference in the length of thoracolumbar spine on radiographs of patients with idiopathic scoliosis as compared to those of controls, but the girls with scoliosis, at the time of puberty showed a faster spinal growth, the growth starting one year ahead to those of controls[6]

The girls with idiopathic scoliosis have been proved to have a propensity to be taller and leaner than their peers. The children with scoliosis have been identified to have more slender and longer spine than those with no scoliosis. The pattern of spine has been implicated towards column-buckling. Early adolescence stage has been seen to have a tendency towards fast growth, just when chances of scoliosis are high, it is suggested that the buckling of spine during growth results in failure of posterior ligaments to grow in response to the anterior growth and results in spinal lordosis. The vertebrae belonging to the segment of lordosis translate to the side and result in scoliosis during forward bending[7]

BIOMECHANICAL CONSIDERATIONS

Over the past few decades various studies have proposed the role of the paraspinal muscles in the mechanism of Adolescent Idiopathic Scoliosis (AIS). Controversies among authors prevails regarding the onset of AIS is a result of the faulty musculature or the actual changes in the muscles are due the structural changes that predispose the muscle pathology[8]. Several studies included about the muscle related to other segments particularly those in pelvic and shoulder girdle region. Very few evidences are there sighting such consequences of AIS on the structures.

The action of scapular muscles using surface electromyography, revealed that there was a delay in activation of superior and inferior trapezium, the serratus and anterior deltoid muscles in individuals with AIS[9]

The involvement of hip musculature by evaluating flexor and extensor group in patients with AIS. The study concluded that there was alteration of flexors and extensors hip muscles like rectus femoris, ilipsoas and gluteus maximus. With left lumbar curvature, flexors of right hip and extensors of left hip were found to be increased in strength. With right lumbar curvature flexors of left hip and extensors of right hip were found to be increased in strength[8]

In a morphologic and morphometric study involving 15 cases of AIS, myopathic changes and a marked reduction in type II fibers was found only on the concave side suggesting AIS to be a diffuse disease process and may be considered basically as a muscle at fault[10]

A comparative study was carried out to find the functional changes in muscles of patients of AIS and healthy individuals during functional tasks by electromyography. They found that quadratuslumborum, gluteus medius, gluteus maximus and abdominals has decreased strength in both group. In the AIS group there was increased activity of erector spinae and quadratuslumborum with no marked differences between concave and convex side. Thus it was suggested that some compensatory mechanism plays a major role to maintain the stability among muscles due to the structural changes suffered in scoliosis[11]

RISK FACTORS

Environmental: There are two critical stages in the development of body posture during the school years. These are the age when a child goes to school and the attainment of puberty. They pose some risks to the quality of the body posture, occurring during the puberty stage, in the period of 6-7 and 12-16 years old. During this the child is most vulnerable to the impact of various external factors and the development of the muscular system is does not follow the rapid growth of the bones. Role of the external environment in which a child resides have a significant impact on the child's posture. It depends on the knowledge and activity of the organizers of the environment that is parents and teachers. This determines the foundation of the entire educational and social activities in the corrective process[12]

The ill effects of heavy back packs in school children found to carry a high incidence of postural deformities like kyphosis (56.6%), lordosis (16.6%) and scoliosis (26.67%).However, these deformities were unnoticed by parents[13]

The serum levels of tartrate-resistant acid phosphatase serum band, 5(TRAP5b) was correlated between bone metabolism and bone density. It was found that lower bone density in AIS patients showed higher rates of bone resorption[14]

A cross-sectional study on pre and post menarcheal girls with AIS was identified with lower serum levels of 25 Hydoxyvitamin D (25-OH-D3) and calcitonin in subjects with AIS. Calcitonin levels were found to be two times less in AIS group as compared to age matched healthy subjects. The study concluded that the deficiency of vitamin D can have a role in AIS[15]

EPIDEMIOLOGICAL CONSIDERATIONS

The incidence of scoliosis was screened among school going children of Lower Assam in the age group of 5 to 16 years. Scoliosis was reported in 0.2% of population with girls having predilection over boys by a ratio of 2.2:1. The study also concluded that idiopathic variety was the most common aetiological curve and the thoracic segment is commonly involved[16]

The prevalence of scoliosis among children in three Thai schools revealed a higher incidence of scoliosis in girls as compared to boys with a ratio of 1.7:1[17]

AIS with a prevalence of 0.47-5.2% is a common disease having a female to male ratio of 1.5:1 to 3:1 and this ratio has been seen to increase with age. Also the occurrence of increased Cobb angle is considerably higher in girls than in boys[18]

Screening of scoliosis at Singapore Schools in the age group of 9 to 13 years of both gender, using the scoliometer to find out the angle of trunk rotation. The study reported that there was a significant increase in prevalence rates in the age group 10-11 years and 12-13 years. They recommended that screening for females should be done annually from 10 years till 13 years of age[19]

COMMON EVALUATION METHODS

Three non-invasive techniques namely scoliometer, back contour device and moiré topographic imaging were used to measure scoliosis and it was found that all the three techniques are sensitive in certain segments and cannot be used interchangeably in clinical records[20]

Persons with scoliosis show alteration in postures while standing with prominence of deformity of the rib cage. Various methods evolved for evaluating the relation between the extents of rib cage deformity observed external and internal spinal changes. Identification of scoliotic curves usually done in the form of screening program started at schools. These programs are directed towards early identification and intervention before they become worse[21]

To quantify scoliosis several clinical measures have been introduced and still evolving as the need of a more precise measure is still there. The advantages of such methods are that they can provide a quantitative value that can be used to track the progression or regression of the curves[22]

The scoliometer is a reliable and simple instrument which detects the rotational deformity of the spine which is very often associated with scoliosis. The measurement by the scoliometer had good reproducibility though its correlation with lateral curvature of the spine was low. Thus the scoliometer cannot alone be used as a diagnostic measure[23]

A study using Walter reed visual assessment scale (WRVAS) to correlate curve pattern and radiographic findings in scoliosis concluded that WRVAS is not sensitive for measuring the segmental changes[24]

Advanced technology in the form of iphones have been used for Cobb measurements and results have shown that the new generation smart phones are as efficient as certain conventional Cobb measurement tools like manual protector. Also the use of iphones as Cobb measurement tool has been seen to be 15% less time consuming when compared to its traditional counterpart. Mobile phones with inclinometer application with storage facility of measurements in updated versions of the software for measurement of angle may make these modern tools useful for clinical measurement applications.[25]

The validity, reliability and evaluation of the scoligauge iPhone app, shows outstanding intra and inter observer dependability and validity comparable to that of scoliometer. They also suggested that this application is an effective means for evaluating clinical measurements even without a special adapter[26]

SCIENTIFIC EXERCISE APPROACH TO SCOLIOSIS (SEAS)

SEAS is the acronym for "Scientific Exercise Approach to Scoliosis," denoting all by itself the basis of the methodology[28]. The changes to the approach do not result from random decisions of the authors but are instead based on the measured introduction of new facts gleaned from scientific literature[27]

The SEAS began from continuing efforts dating back to 1960s, when a scoliosis centre was established in Italy by Vigevano, Antonio Negrini and Nevia Verzini which later became to be known as "Centro Scoliosi Negrini" (CSN). They devised a treatment which employed exercises directed towards therapeutic goals. Due to their continuing efforts the authors founded "Italian study Group of Scoliosis" and had a vital role in finding best scientific papers related to conservative treatment of scoliosis during their systemic work from 1978. Although Lyon school first showed through their

study the efficiency of exercises for AIS when they included results of more than 100 patients of CSN, the evidence of physiotherapeutic treatment had not yet been produced[28]

Progress of the spine stability in active self-correction is the key objective of SEAS. Exclusively, the exercise implemented through SEAS is intended to train neuromotor function leading to self-correction of posture during the activities of daily living[28]. As a result, active self-correction according to the SEAS must be skilled without external aid. The experienced therapist conducts 3 to 4 sessions in a year, with one session lasting for about 1.5 hour. The patient continues his exercise programme at home with a daily session of 15 minutes or a minimum of 2 or 3 sessions of 45 minutes each per week.[27]

Exercise plays a key role to minimize the development of curve below 20^0 in AIS. The study reported that to improve the quality of life (QOL) in AIS, supervised exercise programme was superior when compared to controls in diminishing the spinal deformities[29].

A randomised controlled trail on the effect of the exercise on progression of AIS, recommended exercises can be advocated according to level-1b evidence with the aim of reducing scoliosis progression. However no data exists regarding exercises or when braces can be used.[28]

DISCUSSION

Progress of the spine stability in active self-correction is the key objective of SEAS, which improve the quality of life (QOL) in AIS[28]. Instrumented posterior correction, regarded as major spinal surgery has been in use for several years but has caused a loss of large blood volumes often necessitating replacement of blood.[30] This critical blood loss following spine fusion for AIS is now being acknowledged in large national databases. The complication rate linked with spine fusion for correcting deformities in AIS has been considered to be in the range of 5 to 23%.[31] The various complications that may arise after spine fusion for AIS are gastrointestinal complications, site infection and implant-related complications, venous thromboembolism. The 30 day readmission rate for AIS was 2.66% and the most common causes were found to be either site infection or disturbances of gastrointestinal system (GI) [30]

The scoliosis research society (SRS) has shown a complication rate of 5.7% following spinal fusion surgeries that was recorded between 2001 and 2003 among 6334 AIS patients, with disproportionate values of 5.2%, 5.1% and 10.2% for anterior, posterior and combined respectively. The SRS has recently updated an overall complication rate for AIS to 6.3%.[31]

The outcome of spine fusion surgery has been seen to affect both clinically and as increased healthcare expenditure in the form of duration of hospital stay, added diagnosis, societal expenditure, treatments, loss of productivity, out of pocket charges and outpatient visits.[32]

The operation related complications for AIS has remained comparatively stable despite a huge 193% increase in surgical procedures amounting to 5228 surgeries in 2012 compare to 1783 cases in 1997.[31]

CONCLUSION

Individuals with AIS most commonly fall in the age group of 9 to 10 years. These children are mostly found to be unaware of the fact. Various high risk factors predispose the pre pubertal females for AIS. Developing practice guidelines in the form of a simple group activity may improve the quality of life of AIS children which can be followed in school setting.

CONFLICT OF INTERESTS

The authors declared that there is no conflict of interests regarding the publication of this paper.

HUMAN AND ANIMAL RIGHTS AND INFORMED CONSENT

This article does not include any studies with human or animal subjects performed by any of the authors.

ACKNOWLEDGMENT

The authors thank Dr. Vinitha Ramanath *Pai,* Professor & Deputy Director, MPhil & PhD Program, Yenepoya University for spending her valuable time and support during our work.

REFERENCES

1. *Lowe TG*, Edgar M, Margulies JY, Miller NH. *Etiology of idiopathic scoliosis*: *current trends in research*. J Bone Joint Surg Am. 2000 Aug; 82-A (8):1157-68.
2. *Dimeglio A. Growth in pediatricorthopedics. In: Morrissy, R.T., Weinstein, S.L. (eds.) Lovell and Winter's Pediatric Orthopaedics, 6th edn, pp. 35–65. Lippincott Williams & Wilkins, Philadelphia (2006).*
3. Ganey T, M Ogden, J A. Development and maturation of the axial skeleton. In:Weinstein, S.L.(ed.) The Paediatric spine. Principles and practice,2nd edn,pp. 3-54. Lippincott Williams & Wilkins, Philadelphia (2001).
4. *Dimeglio A: Growth of the spine before the age 5 years. J. Pediatr. Orthop. B 1, 102–107 (1992).*
5. Dickson RA. Scoliosis in the community. Br Med J (Clin Res Ed). 1983 Feb 19; 286(6365): 615-8.
6. Miller NH. Genetics of familial idiopathic scoliosis. ClinOrthopRelat Res. 2007 Sep; 462 (462):6-10.

7. Willner S, Johnson B. Thoracic kyphosis and lumbar lordosis during the growth period in children. Acta Paediatr Scand. 1983 Nov; 72(6):873-8.
8. Pingot M, Czernicki J, Kubacki J. Assessment of muscle strength of hip joints in children with idiopathic scoliosis. Ortop Traumatol Rehabil. 2007; 9(6):636-43.
9. Lin JJ, Chen WH, Chen PQ, Tsauo JY. Alteration in shoulder kinematics and associated muscle activity in people with idiopathic scoliosis. Spine (Phila Pa 1976). 2010; 35(11):1151-7.
10. Sahgal V, Shah A, Flanagan N, Schaffer M, Kane W, Subramani V, et al. Morphologic and morphometric studies of muscle in idiopathic scoliosis. ActaOrthop Scand. 1983; 54(2):242-51.
11. Mahaudens P, Thonnard JL, Detrembleur C. Influence of structural pelvic disorders during standing and walking in adolescents with idiopathic scoliosis. Spine J. 2005; 5(4):427-33.
12. Lizak D, Czarny W, Niewczas M. The problem of postural defects in children and adolescents and the role of school teachers and counsellors in their prevention. Scientific Review of Physical Culture.2016 (4): 4.
13. Mrinal Das, Bakul Let, Dr. SantanuPatar , Rathindranath Datta. Postural defect of school going children due to heavyweight bag", International Journal of Current Research.2015 May ;(7):16278-79.
14. Ko Ishida1, Yoichi Aota, Naoto Mitsugi1, Motonori Kono, Takayuki Higashi, Takuya Kawai, et al., Scoliosis: Relationship between bone density and bone metabolism in adolescent idiopathic scoliosis (2015) 10:9 DOI 10.1186/s13013-015-0033-z
15. GoździJaśkiewicz J, Knapik-Czajka M, Drąg J, Gawlik M, Cieśla M,.zialska A, et al. Association of Calcium and Phosphate Balance, Vitamin D, PTH, and Calcitonin in Patients with Adolescent Idiopathic Scoliosis. SPINE 2016 Volume 41, Number 8, pp 693–697.
16. Saikia K C, Duggal A, Bhattacharya P K, Borgohain M. Scoliosis: an epidemiological study of school children in lower Assam. Indian J Orthop 2002; 36:243-5.
17. Sakullertphasuk W, Suwanasri C, Saetang L , Siri N , Junsiri P, Yotsungnoen S , et al. Prevalence of Scoliosis among High School Students. J Med Assoc Thai 2015; 98 (Suppl. 5): S18-S22.
18. Konieczny MR, Senyurt H, Krause R. Epidemiology of adolescent idiopathic scoliosis.J Child Orthop. 2013 Feb; 7(1):3-9
19. Flordeliza Yong, Hee-Kit Wong, Khuan-Yew Chow. Scoliosis Among Female Students in Singapore. Ann Acad Med Singapore. 2009; 38:1056-63.
20. Pearsall DJ, Reid JG, Hedden DM. Comparison of three non-invasive methods for measuring scoliosis. Phys Ther. 1992 Sep; 72(9):648-57.
21. Vrtoven T, Pernus F, Likar B. a review of methods for quantitative evaluation of spinal curvature. Eur spine J.2009; 18:593-607.
22. Mehta SS, Modi HN, Srinivasalu S, Chen T, Suh SW, Yang JH, Song HR .Inter observer and intra observer reliability of Cobb angle measurement: endplate versus pedicle as bony landmarks for measurement: a statistical analysis. J Pediatr Orthop 2009, 29(7):749-754
23. Sanders JO, Polly DW, Cats-Baril W, Jones JA, Lenke LG, O'Brien MF, et al. Analysis of patient and parent assessment of deformity in idiopathic scoliosis using the Walter Reed Visual Assessment Scale. Spine 2003, 28:2158-2163
24. Pineda S, Bago J, Climent JM, Gilperez C: Validity of the Walter Reed Visual Assessment Scale to measure subjective perception of spine deformity in patients with idiopathic scoliosis. Scoliosis 2006, 1:18
25. Shaw M1, Adam CJ, Izatt MT, Licina P, Askin GN. Use of the iPhone for Cobb angle measurement in scoliosis. Eur Spine J. 2012 Jun; 21(6):1062-8
26. Balg F, Juteau M, Theoret C, Svotelis A, Grenier G. Validity and reliability of the iPhone to measure rib hump in scoliosis. J Pediatr Orthop. 2014 Dec; 34(8):774-9
27. Romano M, Negrini A, Parzini S, Tavernaro M, Zaina F, Donzelli S, et al . SEAS (Scientific Exercises Approach to Scoliosis): a modern and effective evidence based approach to physiotherapic specific scoliosis exercises. Scoliosis. 2015; 10: 3
28. Negrini S, Grivas T B, Kotwicki T, Maruyama T, Rigo M, Weiss H R. Why do we treat adolescent idiopathic scoliosis? What we want to obtain and to avoid for our patients. SOSORT 2005 Consensus paper. Scoliosis. 2006; 1:4
29. Shahnawaz Anwer, Ahmad Alghadir, Md. Abu Shaphe, Dilshad Anwar. Effects of Exercise on Spinal Deformities and Quality of Life in Patients with Adolescent Idiopathic Scoliosis BioMed Research International.
30. Miao Y, Ma H, Guo W, Wu J, Liu Y, Shi W et al. The Efficacy and Cost-Effectiveness of Cell Saver Use in Instrumented Posterior Correction and Fusion Surgery for Scoliosis in School-Aged Children and Adolescents. PLoS ONE. 2014;9(4):e92997.
31. Murphy RMooney J. Complications following spine fusion for adolescent idiopathic scoliosis. Curr Rev Musculoskeletal Med. 2016;9(4):462-469.
32. Yeramaneni S, Robinson C, Hostin R. Impact of spine surgery complications on costs associated with management of adult spinal deformity. Current Reviews in Musculoskeletal Medicine. 2016;9(3):327-332.